

## **SECTION 11002 - EQUIPMENT SUPPORTS, GROUTING AND INSTALLATION**

### **City of San Diego, CWP Guidelines**

#### **PART 1--GENERAL**

##### **1.1 WORK OF THIS SECTION**

- A. This Section specifies minimum requirements for equipment supports, including concrete housekeeping pads, equipment bases, supports, anchorage, and accessories with weights greater than 200 pounds. If conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.
- B. The CONTRACTOR shall provide all supports, anchorage, and mounting of all equipment, unless otherwise specified in accordance with the manufacturer's recommendations, and requirements of industry standards. Each piece of equipment shall be anchored to resist the greater of the maximum lateral and vertical forces required by the local governing code or by the manufacturer of the equipment, whichever is greater. This force shall be considered acting at the center of gravity of the piece under consideration. No equipment shall be anchored to vertical structural elements without written approval of the CONSTRUCTION MANAGER. The CONTRACTOR shall provide all elements required to resist the calculated forces described herein or required by the equipment manufacturer. The CONTRACTOR shall provide certification that for equipment, 20 horsepower and larger, anchor bolt calculations showing adequacy of bolt sizing and anchor embedment have been performed and signed by a registered structural or civil engineer.

##### **1.2 SPECIFICATIONS AND STANDARDS**

- A. This Section contains references to the following documents. It is a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/HI 1.3.4	Centrifugal pumps, Horizontal Baseplate Design
ANSI/HI 1.4	Centrifugal Pumps – Installation, Operation and Maintenance
ANSI/HI 2.4	Vertical Pumps – Installation, Operation and Maintenance
API 610, 1995	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASTM C531	Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacing.
ASTM C579	Compressive Strength of (Method/B) Chemical Resistant Mortars and Monolithic Surfacing.
ASTM C638	Tensile Properties of Plastics.
ASTM C882	Bond Strength of Epoxy-Resin Systems Used with Concrete
ASTM C884	Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
ASTM C1181	Creep of Concrete in Compression
ASTM D2471	Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins
SSPC	Society for Protective Coatings Specifications, Vol. 2

### 1.3 SHOP DRAWINGS AND SAMPLES

A. The following information shall be submitted in accordance with Section 01300:

1. Shop drawings for all equipment bases and anchorage details.
2. Certification of anchor bolt calculations specified in paragraph 11002-1.1 B.
3. Machine and equipment base installation schedule with manufacturers' anchor bolt torque requirements, as specified in paragraph 11002-2.1.
4. Results of grout strength tests, as specified in paragraph 11002-3.2 E.

## **PART 2--PRODUCTS**

### **2.1 GENERAL**

- A. Unless otherwise specified, equipment and drivers shall be rigidly mounted on a common cast iron or fabricated steel baseplate or soleplate grouted into place on concrete housekeeping pads. All equipment shall be mounted on concrete housekeeping pads. Under no circumstances shall equipment supports be grouted directly to concrete slabs or floors. Bases for equipment shall be hot-dip galvanized after fabrication unless otherwise specified. Mounting pads for equipment shall have the zinc layer removed and shall be finished flat and parallel after galvanizing. Sole plates and leveling plates shall not be galvanized. Machined surfaces shall be protected with two layers of duct tape after machining and before shipment from the factory.
- B. Prior to initiating any installation efforts, the CONTRACTOR shall produce a machine base schedule containing the expected dates for setting anchor bolts, casting housekeeping pads, preparation of housekeeping pads for grouting, grouting, and final anchor bolt clamping for each item of equipment. The schedule shall list the equipment, by equipment number, and shall be accompanied by written verification of anchor bolt clamping torque from the equipment manufacturer.
- C. Installation practices shall follow the guidance presented in Chapters 4 and 5 of API Recommended Practice 686, unless superseded by more restrictive requirements of these specifications or manufacturer requirements.

### **2.2 CONCRETE HOUSEKEEPING PADS**

- A. Concrete housekeeping pads for equipment and floor penetrations shall be at least 2 inches larger in plan than the steel or cast base and not less than 6 inches above the finished floor elevation, and shall be shaped to drain liquids away from the base. Housekeeping pad details shall follow the requirements set forth on MWWD Standard Detail M-114A unless superseded by more restrictive requirements of these specifications or the requirements of the equipment manufacturer. All conduits, piping connections, drains, etc., serving the equipment, shall be enclosed by the concrete pad. Unless otherwise specified, no conduits, piping connections, drains, etc., will be accepted which rise directly from the floor.

### **2.3 EQUIPMENT BASES**

#### **A. General**

- 1. Unless otherwise specified, mounting bases for equipment 20 horsepower and larger shall be a minimum of 1 inch thick. All bases shall have edges bearing on the grout surface rounded to a radius of not less than 2 inches to avoid producing stress risers on the grouted foundation. Grout pouring holes shall be provided in all bases and all bases shall have grout release holes. Except where vibration isolation systems are specified, all bases shall be grouted as specified in this Section. Internal stiffeners shall be provided and shall be designed to allow free flow of grout from one section of the base to another. The minimum acceptable opening in cross-bracing and stiffeners shall be 2 inches high by 6 inches in length. All welds shall be continuous and free from skips, blow holes, laps and pockets.

2. Equipment bases for horizontal pumps shall conform to the requirements of this Section, ANSI/HI 1.3.4, API 610 (paragraph 3.3), and shall provide common support for the pump and motor (and flywheel, if one is specified). In the event of conflict, the requirements of this Section shall govern. Eight positioning jackscrews shall be provided for all drivers and flywheels (if specified) for all horizontal pump baseplates. All bases for horizontal pumps shall be equipped with jackscrews for positioning and leveling the base prior to grouting.
3. Mounting holes for anchor bolts in the bases shall be drilled and not burned out and they shall not be open slots. All mounting studs shall be Type 316 stainless steel. Anchor bolts shall be as specified under paragraph 11002-2.6. A non-seize or non-galling compound shall be used on all threads.
4. Mounting pads for equipment shall be machined after all welding and stress relieving and shall be coplanar to 0.002 inch in all directions. Mounting pads shall extend not less than 1 inch on all sides beyond the position for the equipment.
5. Equipment bases - for vertical volute-type pumps weighing more than 2000 pounds - shall be soleplates or leveling boxes under individual feet or support brackets integral with the volute casting. Direct mounting of the volute on housekeeping pads will not be permitted.
6. Sole plates, mounting blocks and baseplates weighing more than 1000 pounds shall be leveled with jackscrews incorporated into the fabrication. Jackscrews shall be located in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
7. The seismic design of equipment bases shall conform to the requirements of paragraph 11000-2.2J.

#### **B. Type I Bases**

1. Type I bases shall be structural steel bases with thickened steel pads for doweling. The bases shall be rectangular in shape for equipment other than centrifugal refrigeration machines and pump bases, which may be "T" or "L" shaped to accommodate the equipment drive and accessories. Pump bases for split case pumps shall include supports for suction and discharge base ells, if required by the specified configuration. Perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Terminations requiring connections to the base shall be nuts welded to the bottom side of the base and plugged with cork, plastic plugs or grease, or acorn nuts. Grout holes shall be provided for the bases of all equipment where vibration isolation is not specified.

#### **C. Type II/III Bases: (NOT USED)**

#### **D. Type IV Bases**

1. Type IV bases shall be cast iron. Cast iron bases located within buildings do not require galvanizing but shall be sealed in accordance with the requirements for bleeding surfaces specified in Section 09800 prior to grouting. Terminations requiring connections to the base shall be nuts welded to the bottom side of the base and plugged with cork, plastic plugs or grease, or

acorn nuts. In no case shall the fastener terminate only into the metal base.

#### E. Sole Plates

1. Where sole plates are provided, the underside shall be scribed with the words "THIS SIDE DOWN" using welding rod material prior to milling the equipment mating surface flat to a tolerance of not less than 0.002/foot in all directions. Sole plates shall be designed to be installed in the housekeeping curbs shown.

### 2.4 GROUT FOR EQUIPMENT BASES

#### A. Epoxy Grout

1. Unless otherwise specified, grout for equipment bases shall be non-shrinking epoxy grout conforming to the following requirements:

Test	Result
ASTM C531	Shrinkage shall be less than 0.080% and thermal expansion less than $17 \times 10^{-6}$ in/in/°F
ASTM C579	Strength shall be a minimum of 12,000 psi in 7 days when tested by method B, modified.
ASTM C882	Bond strength to Portland concrete shall be greater than 2000 PSI
ASTM C884	Epoxy grout shall pass the thermal compatibility test when overlayed on Portland cement concrete
ASTM D638	Tensile strength shall not be less than 1700 psi. Modulus of elasticity shall not be less than $1.8 \times 10^6$ psi
ASTM C1181	Creep of the epoxy grout shall be less than 0.005 in/in with the test at 70°F and 140°F with a load of 400 psi
ASTM D2471	Peak exothermic temperature shall not exceed 110°F when a specimen 6 inch diameter x 12 inches high is used. Gel time shall be a least 150 minutes

2. The vehicle shall be a two-component (liquid and hardener) system designed to yield the above characteristics when combined with the manufacturer's recommended aggregate system. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperature as high as 150 degrees F, with a load of 1200 psi. Aggregate for equipment base grout shall be as furnished by the manufacturer of the epoxy grout mix.

#### B. Cementitious Grout

1. Cementitious grout for use with equipment supports for equipment rated 5 horsepower and smaller or weighing less than 1000 pounds, whichever is less, shall be non-shrink grout as specified in Section 03315. Procedures for leveling and clamping equipment shall be as specified in this Section.

## 2.5 EPOXY PRIMER

- A. The epoxy primer shall be a lead free, chrome free, rust inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer shall be a product of the epoxy grout manufacturer.

## 2.6 ANCHOR BOLTS

- A. Anchor bolts shall be as specified in paragraph 11000-2.20, set in PVC sleeves. Sleeves shall allow a free length projection of not less than fifteen bolt diameters above the concrete required to develop the strength of the bolt. Projection above the nut on the baseplate or soleplate shall be no more than 3/4 inch. Anchor bolts shall be located not less than 6 anchor bolt diameters from the foundation edge in all directions.

# PART 3--EXECUTION

## 3.1 GENERAL

- A. Pumps shall be installed in accordance with this Section and ANSI/HI 1.4 and ANSI/HI 2.4. Grouting of equipment bases shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless the CONSTRUCTION MANAGER accepts an alternate installation procedure in writing, baseplates shall be grouted with the equipment removed.
- B. Equipment that is not mounted on vibration isolators shall be anchored directly to the supporting floor system. In addition to the anchorage, all such equipment shall be internally designed so that all static and moving parts are anchored to the supporting framework to resist the all imposed forces. All forces shall be transmitted to the base in order to be anchored as required.
- C. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections. Where the equipment manufacturer requires a rigid connection between the machine and connecting piping systems (generally, this will be higher discharge head pumps), the flexible coupling shown may be deleted and the CONTRACTOR shall install the equipment in the following manner:
  - 1. The equipment housekeeping pad shall be prepared as specified under paragraph 11002-3.2 B.
  - 2. The baseplate, soleplate or leveling blocks supporting the equipment shall be installed, leveled, and grouted in place as specified.
  - 3. The equipment shall be installed, aligned and doweled in place as specified.
  - 4. The piping shall be installed and aligned to the equipment connections and the field piping connections without welding on the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted up and pressure tested.

5. All piping shall be fully supported by supports designed to accept their full weight.
  6. The final sections of pipe shall be aligned with the equipment and field connections without the use of jacks, chain falls or other devices to force it into alignment.
  7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the CONSTRUCTION MANAGER.
- D. Conduit and piping for future equipment shall be capped flush with the floor or concrete pad in such a manner to allow future connection.
- E. The CONTRACTOR shall coordinate location of electrical conduit and piping penetrations within the concrete pad and equipment base. All penetrations shall stub-up on the same side of the equipment as required for connection to the equipment. Equipment drains shall be located as required for drainage from equipment.
- F. Prior to commencing equipment installation work, the CONTRACTOR shall cause the manufacturer of the epoxy grout to be used for equipment installation to conduct a training school for the workmen to be using the product. The school shall be not less than 4 hours in length and shall cover all aspects of using the products from mixing to application. This requirement, however, shall not be construed as relieving the CONTRACTOR of overall responsibility for this portion of the work.

### 3.2 INSTALLATION

#### A. Anchor Bolts

1. Prior to concrete placement, anchor bolts shall be accurately set according to the manufacturer's foundation drawings and firmly secured to prevent shifting during concrete placement. Drilled in anchor bolts will not be accepted. The bolts shall be embedded in the structural concrete to develop the full strength of the bolt. Concrete in housekeeping pads cannot be used for this purpose. All anchor bolts shall be dimensionally checked against the foundation drawings for proper length, diameter, thread length, thread projection, etc., by a representative of the equipment manufacturer prior to placing concrete. Prior to placing concrete for the housekeeping pad, plastic sleeves shall be placed around each bolt to provide for minor adjustment of bolt position prior to grouting. Sleeves shall be filled with a pliable, nonbonding material such as silicon rubber or wax to prevent contact between the concrete or grout and the anchor bolt. Bolt threads and projections in the sleeves (refer to paragraph 11002-2.6) above the structural slab shall be protected in the sleeve by heavily greasing or waxing the threads and shank with paste wax and wrapping with plastic sheeting. The protective wrapping shall be firmly secured with tie wires. The protective wrapping shall be removed prior to placing the grout.
2. The equipment manufacturer shall recommend the size of the anchor bolts for the equipment and shall also furnish the recommended tightening torque for the nuts; however, the minimum size bolt shall be 3/4 inch for equipment rated 20 to 100 horsepower, 1 inch for equipment rated over 100 to 300 horsepower and 1-1/4 inches for 300 to 500 horsepower. Anchor bolts for equipment rated over 500 horsepower shall be as recommended by the manufacturer of the equipment and as approved by the CONSTRUCTION MANAGER.

## **B. Concrete Housekeeping Pad Preparation**

1. After the concrete is fully cured (sample cylinders, as specified in Section 03300, shall be taken and tested for all housekeeping pads supporting equipment weighing more than 1000 pounds), the housekeeping pad shall be chipped approximately 3/4 inch to 1 inch to remove all laitance and defective or weak concrete. A light duty, hand held pneumatic chipper with a chisel type tool shall be used for chipping the foundation. Abrasive blast, bush-hammer, jack hammers with sharp chisels or needle gun preparation of concrete surfaces to be grouted are not acceptable. The amount of concrete removed shall be such that the final baseplate or soleplate elevation results in not less than 3 inches of grout between the surface of the housekeeping pad and lower baseplate flange or the underside of the soleplate.
2. All edges shall be chamfered 2 to 4 inches at a 45-degree angle. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and cover the foundation shall be covered with protective plastic sheeting. The grout contact surface on the housekeeping pad shall be coated with one coat (not more than 5 mils) of catalyzed epoxy resin.

## **C. Equipment Bases and Soleplates**

1. All surfaces of equipment bases and soleplates to be in contact with epoxy grout shall be cleaned to SP-6 and shall be primed with epoxy primer within 8 hours of cleaning.

## **D. Leveling and Shimming**

1. All machinery shall be mounted and leveled by millwrights. All equipment bases and equipment shall be leveled against steel surfaces. Use of other materials for leveling purposes is strictly and specifically prohibited. Unless otherwise specified, baseplates, mounting blocks and soleplates weighing less than 1000 pounds shall be leveled on stainless steel blocks 4 inches square and 1-1/2 inches thick with a hole drilled in the center for the anchor bolt, placed under the base at every anchor bolt. Leveling shall be by use of mounting blocks machined flat on all horizontal surfaces and measuring not less than 4 inches wide horizontally and shims that shall extend not less than three inches beyond the base of the equipment. Mounting blocks shall be coated with a light oil just prior to beginning the leveling and grouting work. Using precut stainless steel shims coated with a light oil between the base and the steel blocks at the anchor bolts, the CONTRACTOR shall level the equipment baseplates, soleplates or mounting blocks against the anchor bolt nuts (finger tight only) to a maximum tolerance of 0.0005 in./ft or as otherwise required by the equipment manufacturer, if more stringent. Mounting surfaces for equipment shall be coplanar within 0.002 inch in any direction. The shims shall be placed so the tabs on the shims are easily accessible. A minimum of four shims per anchor bolt shall be used. The total shim thickness at each anchor bolt shall be at least 0.015 inch. Leveling shall be against anchor bolts prior to final grouting.
2. The CONTRACTOR shall level the equipment against the anchor bolt nuts to a maximum tolerance of 0.002 in./ft or as otherwise required by the equipment manufacturer, if more stringent. Leveling equipment shall be precision surveying equipment. Machinists' spirit levels will not be permitted for leveling purposes for any base plate or equipment foundation with a plan dimension greater than 4 feet.



3. Leveling nuts may be used for mounting equipment weighing less than 500 pounds. The CONTRACTOR shall level the equipment against the anchor bolt nuts to a maximum tolerance of 0.0005 in./ft or as otherwise required by the equipment manufacturer, if more stringent. Anchor bolt nuts shall be only finger tight during the leveling process. Wedges will not be allowed and under no circumstances shall shims be used as permanent support under baseplates, soleplates or leveling plates.

#### **E. Grouting**

1. Grout forms shall be built of minimum of 3/4-inch thick waterproof plywood and shall be securely braced (minimum brace size shall be 2 inches x 4 inches). Forms shall provide a minimum of 2-inch hydrostatic head above the final elevation of the grout to assist in flow during installation.
2. Forms must be coated with three coats of paste wax on all areas that will come in contact with the grout to prevent the grout from bonding to the forms. Forms shall be waxed before assembly to prevent accidental application of wax to surfaces where the grout is to bond. Before any forms are installed, all concrete surfaces that will contact epoxy grout shall be free from any foreign material, such as oil, sand, water, grease, etc. Forms shall be liquid-tight. Any open spaces or cracks in forms, or at the joint between forms and the foundation, shall be sealed off, using sealant. All outside vertical and horizontal edges of the grout shall have 45-degree chamfers. Blockouts shall be provided at all shimming and leveling nut positions to allow removal of shimming equipment after the grout has cured. Jackscrews shall be coated with a light oil or other acceptable bond-breaking compound.
3. The 45-degree chamfer strip shall be located at the final elevation of the grout. The final elevation of the grout on baseplates with exposed I-beam or C-channel supports shall be at the top of the lower support flange. The top of the grout, on baseplates with solid sides and soleplates, shall be 1.0 inch above the bottom of the baseplate or the underside of the soleplate. The grout's final elevation shall not be so high as to bond the anchor bolt nut and washer.
4. The epoxy resin and hardener shall be mixed in accordance with the grout manufacturer's recommendations. Aggregate shall be slowly added to the mixer one bag at a time. The grout should be mixed only long enough to wet out all the aggregate. Grout shall be placed at the center of one end of the baseplate or soleplate and worked toward the ends in such a manner as to force the air out from beneath the baseplate or soleplate and out the vent holes, to eliminate voids. The grout shall be placed in a manner that avoids air entrapment using a head box to pour grout into the grout holes. When the head box is moved to the next grout hole, a 6-inch high standpipe shall be placed over the grout hole and filled with grout. The CONTRACTOR shall exercise care to never allow the grout to fall below the baseplate level once the grout has made contact with the baseplate. Grout placement shall be continuous until all portions of the space beneath the baseplate or soleplate have been filled. Subsequent batches of grout shall be prepared so as to be ready when the preceding batch has been placed. Under no circumstances shall the grouting operation be halted because of lack of grout mix. After the entire baseplate is full, 6-inch high standpipes shall be maintained over each grout hole, to continue purging of air. When the grout has started to take an initial set (determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.

5. A grout sample shall be taken for each piece of equipment to be grouted. The sample shall be placed in a cylinder of sufficient size to yield three 2-inch x 2-inch x 2-inch test samples. The samples shall be tagged with the equipment number and ambient temperature at the time of placement. The samples shall be tested in accordance with the manufacturer's recommendations. Once the epoxy grout cylinder has been completely filled, it shall be placed next to the foundation of the equipment being grouted and allowed to cure for 48 hours. After 48 hours, the test cylinder shall be tested in accordance with the grout manufacturer's recommendations by an independent testing laboratory. The results shall be reported directly to the CONSTRUCTION MANAGER. Forms shall be removed only after the grout has cured sufficiently and upon specific permission from the CONSTRUCTION MANAGER.

#### **F. Completion**

1. Upon acceptance by the CONSTRUCTION MANAGER and the equipment manufacturer's representative after the grout has reached sufficient strength, the shims shall be removed, and leveling nuts or jack screws backed off to allow the grout to fully support the equipment base, leveling block or soleplate. Removal of extended shimming material (direct mounted baseplates weighing 1000 pounds or less) shall be by sledge hammer, taking care not to damage the grout. Once shims have been removed, or jackscrews backed off, the anchor bolts shall be torqued, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer. Anchor bolts shall be torqued in increments of not more than 25 percent of final value in an alternating pattern to avoid stress concentration on the grout surface. Pockets for access to shims, or leveling nuts shall be filled with grout mix and pointed after the anchor bolts have been torqued to final values.

**\*\*END OF SECTION\*\***